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BOOK REVIEW

Teaching the nature of science: An authoritative and insightful but non-empirical approach

Douglas Allchin: Teaching the nature of science: Perspectives and resources. Saint Paul, MN: SHiPS Education Press, 2013, xiii+310pp, $40.00 PB

Kostas Kampourakis

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Teaching about Nature of Science (hereafter NOS) has been considered an important element of science education for the past 20 years, at least at the academic level—what teachers actually teach in classrooms is, unfortunately, another story. Generally speaking, science educators have come to a consensus that the history and philosophy of science (hereafter HPS) can provide useful insights, under certain conditions, for this purpose. This does not mean that any HPS teaching necessarily contributes to understanding NOS. However, an appropriate selection of topics, under the necessary re-contextualization, can provide very useful pedagogical tools to teach NOS.

Douglas Allchin has been one of the leading figures in this field, having written insightful articles about both how to teach (e.g. Allchin 2000a) and how not to teach (e.g. Allchin 2000b) science content and NOS under an HPS perspective. He has also consistently and repeatedly argued for the proper use of HPS scholarship in teaching about NOS (e.g. Allchin 2003). Most of these articles have been combined to produce the book under review, titled *Teaching the Nature of Science: Perspectives and Resources.* The book is published by SHiPS Education Press, which seems to operate under the direction of the author. Self-publishing one's book is not necessarily bad, but it probably involves a different procedure from that followed by the most prestigious university presses and publishers. However, the book consists of essays most of which have previously been published in professional journals (302), some of which are among the best in the field, and have thus been subject to substantial peer review.

Overall, *Teaching the Nature of Science: Perspectives and Resources* is an interesting book to read, and it is also very readable. As the subtitle indicates, it is divided into two parts: Part I is about perspectives on teaching NOS and Part II is

K. Kampourakis (✉)
University Teacher Training Institute (IUFE) and Section of Biology, University of Geneva, Pavillon Mail, 40 Boulevard du Pont-d'Arve, 1211 Geneva 4, Switzerland
e-mail: Kostas.Kampourakis@unige.ch

about resources for that purpose. Chapter 1, *The Nature of Science: From Test Tubes to YouTube*, is an introduction to the subject. After briefly discussing philosophical issues relevant to it, such as demarcation and falsifiability, the author critically discusses contemporary perspectives on teaching NOS and concludes that his own perspective, which he describes as *Whole Science,* is more appropriate because it focuses on all elements of science (see also Allchin 2011).

Then, in Chapter 2, *History as a Tool,* he describes several ways in which history can be useful to science teachers: (1) to contextualize and motivate science, (2) to clarify concepts, (3) to reveal misconceptions, (4) to celebrate achievements, (5) to promote scientific careers, (6) to develop inquiry skills, (7) to profile NOS, (8) to highlight science as a social process, and (9) to portray the cultural contexts in which science is done. Thus, Allchin supports the use of history to teach NOS (as well as science itself) but also alerts the readers that the use of history for this purpose should be appropriate. This is the topic of the chapters that follow.

Chapter 3, *Myth-Conceptions*, describes historical figures about which myths have become prevalent in science education, such as Gregor Mendel, Alexander Fleming, William Harvey, and Joseph Priestley. Then Allchin analyzes the structure, or architecture as he calls it, of scientific myths and concludes with some suggestions for teaching. Details notwithstanding, the main message of this chapter is very important. If one intends to use the history of science in order to teach NOS, one had better read carefully, and not superficially, primary and secondary sources in order to present an account that is as historically accurate as possible and that does not distort the actual history. The same argument is made in the next two chapters, Chapter 4 *How Not to Teach History in Science* and Chapter 5 *Pseudohistory and Pseudoscience*. Allchin suggests earlier that these three chapters can serve as "rough-and-ready rules for sorting reliable history from ideologically mangled junk" (45). This remains to be seen, as the effectiveness of these rules should be confirmed empirically. However, reading these three chapters would probably alert teachers to read carefully and acquire a good understanding of HPS scholarship before they teach NOS.

Chapter 6 then focuses on the sociology of science and suggests that sociological studies contribute to a rich and comprehensive description of science. It also emphasizes the need for teachers to distinguish between normative (i.e. somehow idealized) and descriptive perspectives of NOS and address both during instruction. In Chapter 7, *Kettlewell's Missing Evidence: A Study in Black and White*, Allchin suggests that the widely known example of industrial melanism and the peppered moth would be more useful to teaching NOS if it were taught in all its complexity rather than in the oversimplified way it is often taught. In Chapter 8, *Teaching Lawless Science*, Allchin comments on whether science teaching should include scientific laws or not, focusing on Boyle's law. So far so good. Again, details notwithstanding, I am confident that most science teachers and educators would probably reconsider their views and teaching practices after reading the book so far, even if they did not entirely agree with Allchin's conclusions. Chapters 10–14 provide several concrete examples that could be used to teach NOS.

The real problem with this book is found in Chapter 9, *Nature of Science in an Age of Accountability*, where Allchin lost an important opportunity: to explicitly

relate his previous discussion to the numerous empirical studies on teaching NOS that have been conducted over the years. To the best of my knowledge, Allchin has never conducted any research with students in a real classroom to investigate whether his approach really works. That Allchin's approach is insightful and informed does not entail that it would work in a real classroom. Of course, one may not be interested to conduct research in real science education and may restrict oneself to theoretical contributions. There is no problem with that. However, Allchin goes beyond that to criticize other approaches that have been tested in real classrooms with real students and teachers. Chapter 9 is extracted from Allchin 2011, and a response to his criticisms there has already been published (Schwartz et al. 2012), so I will not get into the details of this debate here. However, it is surprising that, in Allchin's view, "most such instruments [several kinds of questionnaires] are inappropriate for classroom use" because they "…were designed for educational research… not for evaluating student achievement in a classroom setting" (153).

Allchin then criticizes further these other approaches and provides a number of interesting alternatives. The main issue here is that he overlooks the distinction between the normative and the descriptive he made in Chapter 6. It is one thing how NOS ought to be *ideally* designed to be taught, and Allchin is right in much of what he writes about this, and another thing how NOS can actually be taught in classrooms and what difficulties students and teachers face, and here Allchin seems to overlook numerous published papers focusing on exactly that. Deng et al. (2011) reviewed 105 empirical studies that investigate students' views of the nature of science, highlighting both the strengths and the weaknesses of the various approaches. Unfortunately, Allchin does not provide an in-depth analysis of these studies.

The important point is not only what students *should learn* about NOS but also what students *can learn* about NOS and what their teachers *can teach* them. There is ample empirical research documenting particular difficulties and problems, and this should be critically considered. Teaching about NOS is very difficult; preparing oneself to teach NOS is even more difficult, in my view, and one could spend a whole life trying to understand the relevant debates among philosophers of science. There are recent sophisticated works (e.g. Hoyningen-Huene 2013) that could be very useful for this purpose. I absolutely agree with Allchin's premise that science educators and teachers should be knowledgeable and should not rely on superficial readings of HPS scholarship in order to teach NOS. Kampourakis (2013) is my modest attempt to contribute to this important aim. However, I have also taught NOS to secondary students and teachers and I am aware of the difficulties involved. My most recent and most interesting experience has been to empirically confirm that I could teach some sophisticated philosophy of science by using the approaches criticized by Allchin both in order to facilitate teachers' understanding and in order to assess it (Kampourakis et al. 2013).

To summarize and conclude: *Teaching the Nature of Science: Perspectives & Resources* can be a useful book for science educators and teachers in their attempt to teach NOS. If they already teach NOS, the least this book can do is to make them reconsider their practices and ensure that their reading of HPS scholarship is careful

and detailed. However, this book does not have much to say about how to assess NOS understandings because its suggestions have not been tested empirically. Until they are, my own recommendation is that science educators and teachers consider Allchin's suggestions for teaching NOS, but also look carefully into the numerous empirical studies on teaching and assessing NOS that reveal particular difficulties and obstacles. Paraphrasing Allchin (119), I would suggest that teachers should clearly differentiate between theoretical and empirical studies on teaching NOS and take the conclusions of both of them into account.

References

Allchin, D. 2000a. Mending mendelism. *American Biology Teacher* 62: 632–639.

Allchin, D. 2000b. How not to teach historical case studies in science. *Journal of College Science Teaching* 30: 33–37.

Allchin, D. 2003. Scientific myth-conceptions. *Science Education* 87: 329–351.

Allchin, D. 2011. Evaluating knowledge of the nature of (whole) science. *Science Education* 95: 918–942.

Deng, F., D.-T. Chen, C.-C. Tsai, and C.S. Chai. 2011. Students' views of the nature of science: A critical review of research. *Science Education* 95: 961–999.

Hoyningen-Huene, P. 2013. *Systematicity: The nature of science*. Oxford: Oxford University Press.

Kampourakis, K. (ed.). 2013. *The philosophy of biology: A companion for educators*. Dordrecht: Springer.

Kampourakis, K., N.G. Lederman, J.S. Lederman, and J.P. Jimenez. 2013. *The influence of a philosophy of science course on teachers' views of scientific inquiry and nature of scientific knowledge*. Rio Grande, Puerto Rico: 2013 NARST Annual International Conference.

Schwartz, R.S., N.G. Lederman, and F. Abd-el-Khalick. 2012. A series of misrepresentations: A response to Allchin's whole approach to assessing nature of science understandings. *Science Education* 96: 685–692.